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RESEARCH SEMINAR OF THE MARINE BIOLOGICAL LABORATORY FOR THE YEAR 1903.

The Research Seminar, begun in 1903, was devoted chiefly to informal reports and discussion of work carried on at the Laboratory. It found abundant support and was continued for some weeks after the regular courses ended.

The range of subjects reported upon contrasts strikingly with that of earlier years, when embryology was the main field of productive research at the Laboratory.

The following is a list of the subjects presented, with brief summaries :

July 13. **The Anatomy and Embryology of *Pecten tenuicostatus*.** By GILMAN A. DREW.

Drawings illustrating the structure and development of this form were exhibited and points of interest were discussed. Much of the discussion concerned the nervous system, the circulatory system, the formation of organs, and the excessive development of the posterior portion of this animal.

The visceral ganglia, which supply nerves to the greater part of the body, are very complex, and the different structural regions are very well marked. The pallial nerves have taken on ganglionic structure probably because of the many tentacles and eyes on the mantle margin that they supply. The cerebral and pedal ganglia are small, corresponding to the reduced condition of the anterior portion of the body. Octocystic canals opening on the surface of the body are present.

The circulatory system comprises a definite system of blood channels, but they are probably not lined with endothelium, so that there is no sharp distinction between blood and lymph.

July 15. **The Origin and Relationships of the Rock Pigeons as Revealed in their Color-Patterns.** By C. O. WHITMAN.

The wild rock pigeons present two very distinct color-patterns — (1) the chequered type, and (2) the barred type.

Two black wing-bars on a gray ground have always been held to be the more primitive pattern, and birds of this pattern are supposed to represent the typical *Columba livia*.

The form with black chequers evenly distributed over the wing and back, although once named *C. affinis*, as a distinct species, was regarded by Darwin as a variety derived from the two-barred rock, and his opinion has stood undisputed.

It appears from a comparative study of many species of wild pigeons, and from a study of the variations in domestic species, that the relationship is just the reverse: *C. affinis* is the original rock dove, and *C. livia* is the derived type. Domestic pigeons have come from both sources.

Columba affinis, however, is not the most primitive form among the wild pigeons. It was derived from a more ancient type, best preserved in the turtle doves (*Turtur orientalis* and *Turtur turtur*). In the turtle dove type each feather has a dark center and light edge.

The turtle dove pattern is at the same time a general avian pattern.

The turtle type and the rock type coexist in some forms (*e. g.*, *Phaps chalcoptera*).

The two-barred pattern of *Columba livia* was reached in the simplest way by an even reduction of the dark pigment, which would result, at one stage, in leaving remnant spots on the long coverts and the secondaries.

The process of reduction has run in *one direction* in many, if not all pigeons, and present species have reached different stages, varying all the way from a uniformly spotted condition to four, three, two, one or part of one bar, or no bars.

It appears to be impossible to reverse the direction of evolution, and to advance from one or two bars to a complete or even a partial chequered state.

The white-winged pigeon (*Melopelia leucoptera*) has no black spots or bars on the wing in the adult plumage, but unmistakable evidence of their former existence is seen in *structural* imprints still left on many of the coverts, and in vestigial traces of spots in a few of the juvenal feathers.

July 17. **Effects of Light-rays on an Ant.** By ADELE M. FIELDÉ.

The species used for the experiment was *Stenamma fulvum*, a myrmicid ant. Five queens and about two hundred workers were kept for ten months in each of five artificial nests, one nest roofed with transparent glass, one with opaque glass, one with glass transmitting only red and green rays, and two with glass transmitting only rays of shorter wave-length than blue. These nests were exposed to like temperature, and the ants were fed on the same foods. In all the nests the young passed safely through the egg, the larval and the pupal stage, and reached active life, proving that the cause of the usual hasty withdrawal of the inert young from daylight does not lie in any injury by any of the rays of the spectrum.

The ants are blind to all rays of light other than the ultra-violet, and they avoid the ultra-violet rays in proportion to the intensity of the illumination. They often congregated with their young in the spots where the illumination from the red and green rays was most intense. Orange glass which excludes most of the ultra-violet rays may be used for roofing their artificial nests, and then the ants may be studied with the certainty that they behave as if they were in darkness.

At the end of ten months marked ants from each of the five nests were introduced into each of the other four nests, where they were amicably received, and it was thus determined that exposure to any ray of light in the spectrum does not affect the odor whereby the ants recognize one another.

July 20. **Further Experiments in the Embryology of the Chick.** By F. R. LILLIE.

First, three cases in which the cerebral hemisphere of the right side was destroyed at an early stage, and which resulted, after farther growth of the embryo for four or five days, in displacement of the wing rudiments of the opposite side. This displacement was the same in all cases and was never found in normal embryos. The conclusion was that there is some trophic relation between the higher brain centers of one side and the embryonic tissues, especially muscular tissues, of the opposite side; this be-

ing expressed in the case under consideration by the abnormal growth of the wing. The sections of these embryos show that the parts of the brain posterior to the cerebral hemispheres on the defective side were less developed than on the uninjured side, owing to the absence of descending tracts from the cerebrum of that side. This defect disappeared in the region of the medulla, from which it may be concluded either that the tracts had descended no farther, or that approximately half had decussated. The trophic effect, if any, would be indirect, through the intermediation of the motor neurons of the chord. Subject still under investigation.

A second series of experiments was made involving destruction of the hind end of the embryo, showing, first, that there is no regeneration, and second, that the uninjured embryonic parts developed precisely as they would have done in a normal embryo. Thus, if but a single leg-somite remained, a rudiment of the leg was formed in a developing embryo; but if all the leg-somites were destroyed no rudiment appeared. Absence of the allantois was noted in such embryos.

Other modifications of internal organs were described.

July 22. **Variation and Selection in Saturnid Lepidoptera.**

By HENRY EDWARD CRAMPTON.

An account was given of a study upon variation and its relation to elimination in *Philosamia cynthia*, as well as of additional studies which have been prosecuted during the past five years upon the same, and other problems in the case of *Cynthia* and other saturnid moths. The first points determined were: (1) That when normally formed pupæ which died before metamorphosis, were compared sex by sex with pupæ which lived through the metamorphosis, the two groups were markedly different in several characters, as regards the typical condition as well as the variability with reference to such typical condition. Thus pupal elimination and variation were shown to be related. (2) A comparison of the pupæ which metamorphosed perfectly with those which formed more or less imperfect moths revealed a second period of elimination which again proceeded hand in hand with variation. Thus "secular" and "periodic" selection, so-called

by Pearson, were proven for *Cynthia* of this year (1898-1899). Annual series of the same species exhibited the same phenomena. Three lots of *Cecropia* have been likewise examined, in much greater detail (28 characters), and these also show both kinds of selection.

An enquiry into the occurrence of reproductive selection grew naturally out of the foregoing. Two annual series of *Cynthia* (more than two hundred matings) and two annual series of *Cecropia* (130 and 125 matings respectively) have afforded the basis for the following conclusions: Pupal characters of mating males, or females, when compared with similar characters of the non-mating males, or females, prove to be different in type and restricted in variability. Thus a third period of selection is shown to be correlated with variability.

In discussing the nature of the selective processes, reasons were given for regarding the correlations between the several characters as the real bases for the action of eliminating processes, and not the individual characters themselves.

Further studies, now in progress, were briefly described. These deal with the phenomena of correlation between characters of the individual in its successive larval, pupal and imaginal conditions; with inheritance in pure breeds, and in mixed breeds; and with the correlation of certain physiological reactions with structural characters.

July 24. **White Feathers.** By R. M. STRONG.

The few references in the literature of feather coloration to the causes of white in feathers state that the whiteness is due to the presence of air in the feather substance. This is misleading, for the larger proportion of the white effect is produced by the bar-bules which do not have air-spaces of significant size. The bar-bules are white for the same reason that powdered ice or glass and other transparent substances in a fine state of division appears white.

July 24. **Nervous Regulation of the Heart of Venus Mercenaria.** By R. A. BUDINGTON.

The details of the nervous control of the heart of vertebrates have been worked out in more and more minuteness since the time when

attention was first called to the matter by the Weber brothers in 1846. A similar relation of the nervous system and heart has been shown to hold among the invertebrates also, notably through the work of Conant and Clark on arthropods, of Ransom, Straub, and Yung on mollusca. The last-named worker has described inhibition of the heart of lamellibranchs on stimulation of the visceral ganglion, but no graphic records have been published illustrating experimental investigations of this kind.

In this seminar experimental work on the heart of *Venus mercenaria* was described, and kymograph tracings exhibited, which seem to warrant the following conclusions:

1. Normal rate and character of the heart-beat varies widely with different individuals.
2. Partially exhausted hearts show extreme irregularities.
3. Electrical stimulation of the visceral ganglion causes arrest of the heart.
4. Stimulation of the cerebral ganglion produces no effect.
5. Stimulation of nerves passing from the visceral ganglion to the heart gives results comparable in every way to those obtained from stimulation of the *vagus* in the vertebrates, viz: long after-effects of strong stimulation, and typical escape from weak stimulation.
6. No evidence of acceleration was ever present.

Definitely localized cardiac organs are found in no group of animals generally considered lower than the lamellibranch molluscs. It would therefore seem that, notwithstanding one or two doubtful exceptions, cardiac muscle, wherever found, does not perform its functions entirely independent of inhibitory influences of the central nervous system.

July 27. The Relation Between the Solution Tension and Physiological Action of the Elements. By ALBERT P. MATHEWS.

As already pointed out by Loeb and the author, there is a relationship between the valence of an ion and its physiological action. For the motor nerve anions with three charges are somewhat more than three times as powerful stimulants as anions with one charge. There are, however, for other tissues wide divergencies from this rule, particularly for the cations. For ex-

ample, mercury and copper are enormously more powerful than the bivalent alkaline earth metals ; and hydrogen with one charge is more active than other univalent metals. The author suggested that this divergence from the theory probably meant that it was the motion of the valence or charge which ultimately determined its action and that the velocities or orbits differed for the charges attached to different elements. Dr. Stieglitz suggested that the affinity of the atom for its charge might vary and account for these discrepancies. It occurred to the writer that this affinity might be represented by the solution tension of the element. The more easily the element is separated from a solution of its ions, the less is its affinity for the charge it carries as an ion. I have accordingly compared the poisonous action of the metals and negative elements with their relative solution tension as given by Nernst, using *Fundulus* eggs as test objects. The least concentration of the solution of the chlorides of the different metals which would just prevent the formation of an embryo was determined.

The result showed a marked inverse ratio between the solution tension and poisonous action. Potassium with its great solution tension is almost the least poisonous ; silver with a very low tension is the most poisonous. The other metals arranged themselves in proper order, except that ferric iron, zinc and cadmium were more poisonous than their position in the list of metals would indicate. This discrepancy is probably due to the fact that the solution tension is but a poor measure of affinity between the charge and the element. The anions arrange themselves in order, those parting with their negative charges most easily being most poisonous.

The correspondence is so close as to indicate clearly that the affinity between the electric charge and the atom is a powerful factor in determining physiological action, and that the less strongly the charge is held, the more powerful is the action of any ion.

Experiments were also tried demonstrating that the action of any cation is modified by the action of the anion ; and that of any anion is modified by the action of the cation. There is hence an antagonistic action between anions and cations and the

physiological action of any salt is equal to the sum of the actions of the two ions.

In the toxic and antitoxic action of salts as described by Loeb, both the anion and the cation are of importance. There is no simple relationship of antitoxic action between monovalent and bivalent cations.

July 31. **The Cranial Nerves of *Squalus acanthias*.** By O. S. STRONG.

The object of the work is to confirm, using serial sections, the partial analysis of the cranial nerves into their components accomplished by means of gross dissection by previous investigators, and to extend that analysis further. The components are found to be the same and to have the same general typical arrangement as in other vertebrate types. The trigeminus is purely "general cutaneous." The facialis has four roots: two lateral line roots (R. ophthalmicus superficialis, buccalis, mandibularis externus, etc.) distributed to the canal and ampullary organs of the head, one communis root to the mouth (R. palatinus, mandibularis internus, etc.) and one motor root. The post-auditory roots are the lateral line root, including also a small separate root to one or two canal organs *via* the glossopharyngeus, a series of communis roots and a series of motor roots. The communis roots are distributed into the pre- and post-branchial and visceral branches, innervating the branchial cavities, pharynx and viscera.

July 31. **A Case of Almost Complete Absence of the Left Cerebellar Hemisphere in the Brain of a Child Three Years and Four Months Old.** By O. S. STRONG.

The external appearances have been reported elsewhere (*Journ. Comp. Neur.*, Vol. XI., No. 1). The sections show the following principal abnormalities: absence, usually complete or nearly so, of the right olive and the cerebello-olivary fibers connected with it, of the left restiform body, of the transverse pontine fibers to the left cerebellar hemisphere, of the right *nucleus pontis* and of the left superior peduncle. The left *formatio reticularis* contained more longitudinal fibers than the right. The left lemniscus showed some degeneration and the left *corpus quadrigeminum anterior* was much smaller than the right.

July 29. **Hybrids from Wild Species of Pigeons, Crossed inter se and with Domestic Races.** By C. O. WHITMAN.

The species thus far employed with some success in crossing are the following :

FERAL SPECIES :

1. Oriental turtle (*Turtur orientalis*).
2. European turtle (*Turtur turtur*).
3. Chinese turtle (*Spilopelia*¹ *chinensis*).
4. Surat turtle (*S. tigrina*).
5. Blond ring dove (*Streptopelia*² *risoria*).
6. White ring dove (*S. alba*).
7. Oriental ring dove (*S. torquata*).
8. Red ring dove (*S. humilis*).
9. Passenger pigeon (*Ectopistes migratorius*).
10. Mourning dove (*Zenaidura carolinensis*).
11. White-winged pigeon (*Melopelia leucoptera*).
12. Wood pigeon (*Columba palumbus*).
13. Guinea pigeon (*Columba guinea*).

DOMESTIC RACES :

14. Homer (*Columba tabellaria*).
15. Fantail (*Columba laticauda*).
16. Tumbler (*Columba gyrans*).
17. Archangel (*Columba illyrica*).
18. Mondain (*Columba admista*).
19. Chequered rock (*Columba affinis domestica*).
20. Owl-rock hybrid (*C. turbata* × *C. livia*).

The more important hybrids and their parent species were exhibited, and the importance of *known ancestry*, for definite results, was clearly demonstrated.

With a few exceptions, the hybrids were remarkably close intermediates. Reciprocal crosses gave like hybrids.

Several series of fertile hybrids have been obtained. The most remarkable case was a male hybrid between a male chequered rock pigeon (*C. affinis domestica*) and a female oriental

¹ Sundev, *Math. Nat. Av. disp. Tent.*, p. 100, 1872. The species 1-8 are usually included in the genus *Turtur*. The *Streptopelias* and *Spilopelias* are both sufficiently distinct for generic rank, and it is convenient to deal with them as genera.

² *Bp.-Comsp. Av.*, II., p. 63, 1854.

turtle dove (*Turtur orientalis*). The offspring of this hybrid, mated with the domestic pigeon, exhibited segregation ; but neither in the first nor the second generation were there "dominants" and "recessives" in the Mendelian sense.

No support was found for the so-called "principle of pure germ-cells" in hybrids. Segregation is probably never complete ; and in some cases at least the intermediate character seems to be permanent.

August 3. **On the Presence of Specific Coagulins in Animal Tissues.** By LEO LOEB.

It has been known before that extracts of many animal tissues have an accelerating effect upon the coagulation of the blood. It can, moreover, be shown that there exist in animal tissues specific substances which act specifically upon the blood of animals in which they are found, or upon the blood of related species. I have previously found these specific substances in mammals, birds, reptiles and amphibia. Further investigations show that they exist also in invertebrates. The muscle of the lobster acts more strongly upon the blood plasma of the lobster than upon the blood-plasma of the blue crab ; the muscle of the blue crab acts more strongly upon the blood-plasma of the blue-crab than upon the blood-plasma of the lobster. Pieces of muscle of other animals than arthropods, which have so far been tried, are without effect upon the blood-plasma of the lobster.

For vertebrate blood there exist non-specific or less specific substances like peptone. Similar substances can also be found in certain animal tissues. The specificity of blood-coagula of vertebrates could not be demonstrated among vertebrates, although they become specific if used with invertebrate blood upon which they do not act at all.

Non-specific or less specific substances exist also in invertebrate tissues, as for instance in the ova of *Arbacia* and other animals. They are able to cause a coagulation of the blood of invertebrates which are not closely related.

The origin of these substances, which are peculiarly useful, will probably have to be explained by a process of auto-immunization. This explanation is suggested by the great similarity be-

tween the specific coagulins and substances derived by artificial immunization.

August 5. **The Retinal Nerve-endings in the Eye of Pecten.**

By IDA H. HYDE.

Although the more important methods of staining were tested, none proved so satisfactory as the methylin blue method of Bethe, which was used in a somewhat modified form.

The chief facts regarding the nerve-structure of the eye are as follows: There are two kinds of nerve-tissue. The first is an efferent, or, possibly, a trophic nerve-system, the fibers of which form the side-branch of the optic nerve, and are continuous throughout the peculiar twine-cells to their terminations on the supporting as well as on the nerve-cells in the eye. These fibers penetrate the eye on one side and form a single layer of large unique structures called by the author "twine-cells," as they have the appearance of fibers much coiled in the form of balls of twine. This layer of twine-cells lies between the lens and the retinal disc and on the disc. From these cells fibers extend to other twine-cells, to the tapetum and argentia, as well as to the supporting cells of the retina and as far as the rods.

The fibers are very fine, have a beaded appearance, and are in every respect different from the sensory nerve-fibers, which form the second kind of nerve-tissue.

These sensory nerve-fibers arise as modified nerve-cells, and form the rods which connect with long bipolar cells by means of small dendritic processes. The bipolar cells join the large marginal ganglia by means of nerve-endings in the ganglion. The marginal ganglia form a border of large ganglia cells around the retinal disc, the axones of the ganglia passing in the form of a cup-shaped case over the eye to form the optic nerve. The sensory nerve fibers and cells are surrounded by a hyaline sheath, which is absent in the efferent fibers.

August 5. **The Static Function in Gonionemus.** By LOUIS MURBACH.

The movements of the medusa *Gonionemus* would indicate that it has a definite sense of equilibrium, and some preliminary experiments confirmed this view. To localize this sense experiments

were made to change the center of gravity by weights, etc. These were followed by the removal of different organs, the tentacles, the manubrium and the gonads, but without producing any marked disorientation. It seemed, then, that the otocyst organs to which this function is usually ascribed were thus shown to be active.

At first, solution of the otoliths was attempted with various acids; but it was found that all acids tried, if strong enough to dissolve the otoliths, also killed the animals. Then the vesicles were punctured, putting the otocysts out of function, but in the light of all the experiments there was no definite disorientation, except when the velum was severely mutilated. While this was not a proof that the otocyst organs do not function as the principal organs of equilibrium, the latter observation suggested that equilibration in this medusa is, to a large extent, to be ascribed to "muscular sensation." Further experiments were finally made, cutting away the margin of the bell, including the bases of the tentacles and the otocyst organs. Intermediate portions of the margin were left until healing had taken place; then the remaining portions of the margin were cut away and the animal tested. Although the medusa was more or less imperfect from the operation it was not seriously disoriented but moved in definite directions, including swimming to the surface of a shallow dish of sea water and turning over, also lying with the opening of the bell turned up.

From all the experiments it seems to follow that the otocyst organs serve very little in the equilibrium of the medusæ, and that the muscular sensation is probably the principal factor.

August 7. Nestling and Juvenile Plumages of Sterna hirundo and S. dougalli. By LYNDY JONES.

The ventral downs of the nestling plumage are wholly white, except the throat, where the tips are dusky-black. All dorsal downs have a dusky-black base, then a tawny area, then a dusky-black area, and many a tawny tip. In the nestling *hirundo* these dusky tips are arranged in mottled pattern, but in *dougalli* in stripes. Both patterns are protective, *dougalli* nesting mostly among grasses, *hirundo* originally on the beach among pebbles and seaweed.

The juvenile plumages of the two species present the same general pattern, but differ in detail. In both the ventral plumage is essentially pure white, *dougalli* showing a faint rosy tint. All dorsal feathers are pure white at the base, then, except the remiges and rectrices, which are nearly like the adult feathers, a pearl-gray area, followed by a dusky area, and all feathers with a tawny tip. The inner tertiaries and their lower coverts, and the lower rows of scapulars, have an added area of tawny and of dusky colors. Thus the tawny and dusky areas of the nestling downs are reproduced in the juvenile feather, with the addition, at the inner half of the juvenile feather, of an area of pearl-gray and a white base. The pearl-gray area corresponds in color to the color of the adult feather.

In *hirundo* these markings produce a barred effect, except on the head, which is white at the base of the bill, gradually darkening to black on the crown and occiput. In *dougalli* the outer tawny and dusky areas are parallel to the border of the feather, in the more strongly marked feathers, for fully a third of the length of the feather, and therefore present a more mottled pattern. Some feathers are even distinctly barred with dusky color about their outer third.

The essential pattern of the two plumages is, therefore, a definite barring of each feather on the dorsal surface, and a lack of any marking on the ventral surface. The greatly modified remiges and rectrices closely resemble the adult remiges and rectrices, thus requiring no transition stage, but the rest of the dorsal plumage undergoes a distinct transition from the nestling to the adult, the intermediate, or juvenile plumage, resembling the nestling plumage for its outer half, at least, and the adult plumage for its basal half.

August 7. **The Internal Factors of Regeneration in *Alpheus*.**

By CHARLES T. BRUES.

Alpheus is a small decapod crustacean in which one of the chelæ is larger than the corresponding one on the other side. When one of the larger chelæ is cut off at the base, it has been shown by Przibram, and also by Wilson, that its stump regenerates a chela of the small type, while the originally small one is

remodeled into a large one. Section of the nerve at the base of the small chela inhibits this reversal, wholly or partially.

With regard to the internal factors which induce this reversal it seems at first sight that the nervous system must be the controlling one. Histological examination shows the following facts: (1) Nerves of the right and left sides are not morphologically different except that they branch differently in the two types of claw. (2) During regeneration or remodeling changes occur in their definitive places, *i. e.*, growth does not occur at one end only. (3) The nervous shock of amputation may produce a weakness of the cut side, and also add to the nutriment of the other side of the ganglion, thus inducing reversal. (4) The nerve evidently carries the stimulus to grow, but may be only passive. (5) The cutting of the nerve in the claw may cause a general disease of that organ, such as might be caused by injuring the musculature, and thus prevent perfect reversal.

It appears, therefore, that we must not attribute to the nervous system as much importance in the remodeling as would seem at first sight necessary when it is found that section of the nerve inhibits reversal.

August 12. **The Development of the Vascular System of *Ceratodus*.** By WM. E. KELLCOTT.

The vascular system of the adult *Ceratodus* shows resemblances to both the elasmobranchs and the amphibia. It was thought that the investigation of its development might throw some light upon the significance of this curious combination. A few of the points of interest which appeared in the course of the study are the following:

The heart develops similarly to that of the frog or *Urodele*, from a pair of folds of the splanchnopleure, the somatopleure forming the pericardium.

The branchial arteries also develop similarly to those of the amphibia. They are four in number and early form continuous passages from the ventral to the dorsal aorta. Later they divide into the afferent and efferent vessels and finally each efferent divides, forming the two efferent branchials characteristic of the adult. The vessels of the hyoid arch are well developed early,

but later disappear. The vessels of the mandibular arch are only slightly indicated.

The veins are arranged symmetrically during the early stages. The arrangement of the cardinal veins is typical. A well-marked subintestinal vessel is present very early; later it disappears in part, and in part becomes connected with the hepatic-portal vein. The vena cava is for a time independent of the cardinal system; later the anterior part of the right posterior cardinal disappears, while the vena cava connects with its posterior section. The pulmonary vein appears very late.

Many of the features of the development of the vascular system are closely similar to those of the Urodela. Some, though not all, of the elasmobranch resemblances appear quite late in the process of development and are preceded by conditions which are typically amphibian. There are, however, typical elasmobranch characters present from the first.

August 12. The Metamerism of the Nervous System in Arenicola cristata. By C. P. LOMMEN.

The arrangement of the nervous system of *Arenicola cristata* is definitely related to the annuli forming its somites. A pair of nerves from the ventral cord proceed dorsally between the longitudinal and circular muscles along each of the grooves that separate the annuli. These nerves give off numerous tiny branches, and do not unite dorsally to form rings. In the setigerous annuli there are two additional nerves which are imbedded in the circular muscles, one on each side of the neuropodium. The posterior one divides into two branches, one passing into the gill and the other into the seta-sac. Anteriorly the number of annuli in the somites is gradually reduced from five to two. From the outside of each connective a series of eight nerves is given off, all of which are presumably homologous to the nerves from the cord. This homology has been shown with certainty only in the case of three. Of the remaining five, one innervates the otocyst, the position and muscular connection of which are suggestive of homology with a seta-sac. Fifteen nerves from the inside of the connectives give off some branches to the body-wall and then bend back into the wall of the pharynx, innervating its ventral

and lateral sides, and passing then into the œsophagus. The dorsal wall of the pharynx is supplied by a plexus of nerve-trunks from the brain and the nearest portions of the connectives. The plexuses on the two sides of the body are seldom alike. From the posterior lobes of the brain several nerves pass to the nuchal organ. In the caudal region, the number of annuli in each somite, and with them the number of nerves, may vary from three in the anterior part to nine or ten in the posterior part.

August 14. **The Organization and Orientation of the Ascidian Egg.** By E. G. CONKLIN.

During this summer I have studied the development of three species of solitary ascidians, viz. *Styela* (*Cynthia*) *partita*, *Molgula* *Manhattensis* and *Ciona intestinalis*, with the purpose of finding out how much of organization can be recognized in the unsegmented eggs of these animals.

In the living eggs of all these ascidians, but particularly in the first mentioned, one can recognize the substance of the ectoderm, the endoderm and at least a portion of the mesoderm before the first cleavage occurs.

The spermatozoön enters at the vegetative pole in an area of cytoplasm free from yolk and in *Styela* a dense mass of orange pigment aggregates at this spot and slowly spreads over the vegetative hemisphere. Subsequently it withdraws to one side of this hemisphere, thus forming an orange crescent which lies just below the equator on the posterior side of the egg. The vegetative pole then becomes slate-gray in color and the animal pole a light gray. The study of the subsequent development shows that all the axes of the future animal are now established and that the slate-gray substance forms endoderm, the light gray ectoderm and the orange crescent the muscular system of the tadpole. In *Ciona* and *Molgula* the crescent is present as in *Styela*, but is nearly colorless, while the substance of the ectoderm and of the endoderm may also be recognized in the unsegmented egg.

An incidental result of this work is to prove beyond question than Van Beneden and Julin were right in their orientation of the ascidian egg and that the polar bodies are found at the ectodermal and not at the endodermal pole, as Castle has maintained.

August 14. **Rhythms of Susceptibility and of CO₂ Production in Cleavage.** By E. P. LYON.

Two years ago the author found that the *Arbacia* egg about fifteen minutes after fertilization is very susceptible to lack of oxygen or to KNC. At other times during the first cleavage it is more resistant. This rhythm of susceptibility and resistance recurs in each succeeding cleavage period.

Further investigation shows that cold acts like lack of oxygen. If the eggs are kept at about 0° C. for a number of hours, those which are placed on ice about fifteen minutes after fertilization are much injured, and may wholly fail to develop, while little harm is done to eggs which have passed the critical stage before being cooled. This rhythm recurs in successive cleavages.

Heating the eggs to 33°–38° C. for a few minutes reveals the opposite rhythm. They are most susceptible at the time of cleavage and are little injured ten or fifteen minutes after fertilization or at corresponding stages in the following cleavages.

The CO₂ output of a mass of eggs is greatest at the time of cleavage. At the time when oxygen is most needed, apparently little CO₂ is produced. This shows that the oxygen, in all probability, is needed for synthetic processes and that the CO₂ is produced by splitting and not by oxidation. The rhythm of CO₂ production can be demonstrated also in the second cleavage.

August 17. **The Voices of Pigeons. I. The Voice of the Ring Dove (*Turtur risorius*).** By WALLACE CRAIG (demonstrations with the doves).

Nearly five hundred species of wild pigeons are known, and, so far as observation goes, each species has a perfectly distinct and constant set of notes. These voices have had a common origin, and the problem is to discover this and trace the derivation of homologous elements.

The work consists of two parts, a study of the voice in each species, and a comparison of different species and their hybrids. The former may be further divided into: (1) A description of the different notes, the attitudes which accompany each, and their whole significance in the life of the bird; (2) the development of the voice in the young; (3) a history of the seasonal changes in voice and behavior in the adult bird. The first and second of these subdivisions were reported upon in this seminar, and the

main facts presented were as follows : The adult ring dove has only three principal calls, but these have a number of modifications, which, together with many expressive movements, afford a considerable variety of expression. All these modes of behavior seem to be strictly inherited. They develop in the young bird very gradually, and in a definite order which is probably also the order of their development in the race.

August 24. **Some Reactions of *Mnemiopsis Leydyi* (A. Ag.).**

By GEORGE WILLIAM HUNTER, Jr.

Mnemiopsis orients itself with reference to gravity, being negatively or positively geotropic under differing conditions. It has two characteristic resting positions, one at the bottom with the aboral pole upward and one at the surface of the water with the oral pole upward.

In strong and moderate intensities of light it may be first negatively and later positively photopathic ; to very weak intensity of light it may be positively photopathic. Some evidences of phototaxis are found under strong light, the aboral end being directed toward the light.

The animal reacts toward a moderately strong constant current (one half to three volts) by turning the aboral pole toward the anode and moving to the cathode. A weaker current may cause orientation without movement toward the cathode.

The action of the "make" and "break" upon muscles and cilia depends upon the position of the electrodes and the strength of the current.

Mnemiopsis is relatively more resistant to decrease than to increase in the temperature of the water. Responses to electrical stimulation under conditions of greater heat than normal show decrease in reaction time up to about 29° C., then rapid increase in reaction time. Responses to electrical stimulation under conditions of decrease from normal temperature show little change in reaction time to about 15° C., then a slow increase in reaction time.

August 24. **The Reaction Time of *Gonionemus Murbachii* to Electric and Photic Stimuli.** By ROBERT MEARNES YERKES.

This experimental study of the time relations of the neural processes of *Gonionemus* indicates : (1) A reaction time to elec-

trical stimuli of from .6'' to 2.0'' according to the intensity of the stimulus and the position of the organism; (2) a shorter reaction time when the radial canal regions are stimulated than when the inter-radial regions receive the stimulus; (3) rapid fatigue with repetition of the stimulus; (4) a reaction time to photic stimuli of 1'' to 10'' dependent upon conditions; (5) a much quicker reaction to light when the organism is resting subumbrellar surface uppermost (exposed to the light) than when the exumbrellar surface receives the stimulus; (6) a specialization of organs for the reception of photic stimuli; (7) the existence of highly irritable and conductile tissues (nervous system); (8) that excised organs rapidly lose their irritability; (9) that variability of reaction time for comparative work should be expressed in terms of percentage of the reaction time as well as in absolute terms. This relative variability may be called the variation coefficient.

August 24. The Establishment of "Association by Contiguity" in Hermit Crabs, Eupagurus longicarpus. By E. G. SPAULDING.

Crabs are naturally positively *heliotropic*. They were taught to react *against* this by feeding them in a darkened portion of aquarium. Coefficient of daily improvement in eight days = 6.00. The darkening screen was removed each time after feeding. After seven days the crabs go behind the screen, when inserted, although no food is there. This proves the existence (*a*) of association between two different stimuli and (*b*) that when one of these, the screen, is presented, the usual effect of the other is internally reproduced. This may be interpreted as *conscious memory*.

August 24. The Resin Gnat and Three Parasites: A Study Made in July and August Under the Direction of Mr. Chas. T. Brues. By L. ECKEL.

This study of *Diplosis resinicola* brought to notice three parasites, among a number of additional facts about this insect, whose larval stage is well known to be passed within the lumps of resin that exude from various species of pine, and which pupates within the resin:

1. *Polygnotus pinicola*, a proctotrupid which has been reported as parasitic upon *Diplosis pini-inopis*. It destroys many of the

larvæ of *Diplosis resinicola* in July, twenty transforming in one *Diplosis* larval skin.

2. Two *Chalcis* flies ; one a species of *Syntasis*, described now for the first time as *Syntasis diplosidis*, the second as yet undetermined. They destroy many pupæ of *Diplosis resinicola* in early August.

August 26. On the Artificial Creation of Mixed Nests of Ants. By ADELE M. FIELDE.

Natural mixed nests of ants have been described, but such nests are always of ants belonging to the same subfamily, and not more than two species of ants ever inhabit the same nest.

There are two ways in which an artificial mixed nest may be created ; one is by depriving all its residents of the sense of smell by removing the funicles of the antennæ ; the other is by accustoming all the resident ants from their earliest hours to the odor of each kind of ant that is to occupy the artificial nest. If a nest not larger than a watch-glass be made, and one or more ants from each selected colony be sequestered in this nest, within twelve hours from the moment of hatching, these ants will each touch all the others with the antennæ and will thus become accustomed to and unafraid of the odor of species unlike their own.

An ant reared in isolation will not affiliate with any whose odor differs from its own. Its criterion of correct ant-odor having been formed within three days after hatching, it continues hostile through life to all ants whose odor disagrees with its standard. But by the process of ant-education herein indicated, any ant may be induced to live peacefully with those of a different genus, or even of another subfamily.

Several artificial nests were shown in which ants of four genera, or of all the three subfamilies, were living together, and in which young ants of one genus were snuggling the queen of another genus.

Were the ants in the artificial nests set free, their unlike requirements relating to temperature, humidity and food would soon separate them ; but it is improbable that these individual ants would ever fight with one another on subsequently meeting, although any of them would fight with ants of other colonies than those in which their early companions originated.